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(71) Applicant: **OMRON CORPORATION**
10, Tsuchido-cho, Hanazono, Ukyo-ku,
Kyoto-shi, Kyoto 616(JP)

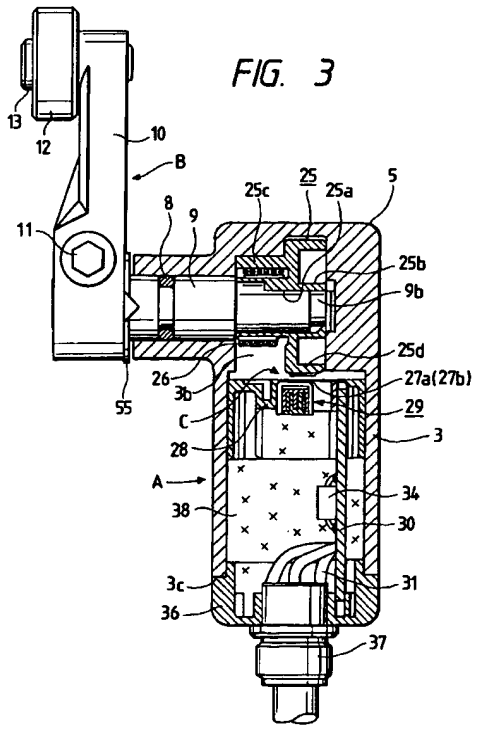
(72) Inventor: **Shinohara, Kenji**
7-18 Kugai 2-chome
Nagaokakyo-shi, Kyoto(JP)
Inventor: **Kishi, Shigenobu**
3-10 Dobashi-cho
Takatsuki-shi, Osaka(JP)

(74) Representative: **Calderbank, Thomas Roger et al**
MEWBURN ELLIS 2 Cursitor Street
London EC4A 1BQ (GB)

(54) Limit switch.

(57) In a limit switch, its rotational operation section B includes a rotary shaft 9 which is rotatably supported on a head housing 5, and an actuator 10 for turning the rotary shaft 9, and its switch section C comprises a detector 29 which is built in a switch housing 3, to detect particular detection parts 27a and 27b in a non-contact mode which are provided on the outer cylindrical surface of a cam 25 mounted fixedly on the rotary shaft 9, thereby to provide a detection signal. The head housing 5 and the switch housing 3 are formed as one unit. A limit switch which is simple in construction and small in the number of components when compared with the conventional limit switch, and can therefore be miniaturized, and which is long in service life and reliable in operation, can be provided.

FIG. 3



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This invention relates to a limit switch which is used in a variety of manufacturing devices or industrial robots. A conventional limit switch of this type is as shown in FIG. 24.

In FIG. 24, reference numeral 1 designates a housing which is made up of a switch housing body 3 incorporating a switch 2, and a cover 4 closing the side opening 3a of the switch housing body 3. A head housing 5 is detachably engaged with the upper end opening 3b of the switch housing body 3 with a plurality of bolts (not shown).

The head housing 5 has a shaft hole 6, in which a rotary shaft 9 is rotatably fitted with a collar 7 and an O-ring 8 in such a manner that one end portion 9a of the rotary shaft 9 is extended outside the head housing 5. An actuator 10 is mounted on the one end portion 9a of the rotary shaft 9 and fixed with a screw 11. The actuator 10 includes a shaft member 13, on which a roller 12 is mounted.

The axis of the rotary shaft 9 is perpendicular to the axis of an operating rod 22 of the switch 2. A flat cam 9c is formed on the other end portion 9b of the rotary shaft 9 in such a manner that it is located on the axis of the operating rod 22.

A bottomed-cylinder-shaped spring receiver 14 is placed on the cam 9c. A return spring 15, which is a coiled spring, is set between the spring receiver 14 and the inner surface of the head housing 5, thus giving a rotational return force to the rotary shaft 9.

On the other hand, an operating plunger 16 is interposed between the cam 9c and the operating rod 22 of the switch 2. The operating plunger 16 comprises a cylindrical plunger body 17, an auxiliary plunger 18 built in the plunger body 17, and a buffer spring 19 interposed between the plunger body and the auxiliary plunger. The operating plunger 16 is axially movably inserted into the upper end opening 3b of the switch housing body 3. A depressing pin 20 for depressing the operating rod 22 is secured to the end of the auxiliary plunger 18.

The switch housing body 3 has a lower end opening 3c, which is closed with a connector (not shown) to which electrical cables are connected.

The limit switch thus constructed operates as follows: When an object such as a workpiece under test abuts against the roller 12, the actuator 10 is turned about the rotary shaft 9 against the elastic force of the return spring. As the actuator 10 is turned in this way, the cam 9c is turned to push the operating plunger, so that the switch 2 is operated.

When the cam 9c is turned in the above-described manner, the spring receiver 14 is displaced to compress the return spring 15. When released, the actuator is returned to the original position by the elastic force of the return spring 15 thus compressed.

In order to operate the switch 2, it is necessary to convert the rotational motion of the actuator 10 into the linear motion of the operating plunger 16. Therefore, the motion converting mechanism is intricate, and accordingly it needs a relatively large number of components, with a result that the limit switch is unavoidably bulky. Furthermore, the limit switch is relatively short in service life, because it has a number of slide parts, and suffers from unreasonable stress.

On the other hand, it is essential to hermetically seal the internal chamber of the switch housing body 3 thereby to protect the switch 2 from damage. For this purpose, it is necessary to set a cylindrical elastic seal member 21 in the upper end opening 3b thereby to maintain the internal chamber 1a airtight.

However, it is rather difficult to maintain the internal chamber airtight for the following reason: In order to permit the reciprocation of the operating plunger 10, it is necessary for the internal chamber 1a of the switch housing 1 to change in volume and in pressure at all times; that is, it is necessary for the internal chamber 1a to breath through the elastic seal member 21 to some extent. Thus, it is difficult to maintain the internal chamber 1a airtight. In addition, the breathing operation of the internal chamber 1a adversely affects the returning operation of the operating plunger, as a result of which the switching operation of the switch 2 is delayed.

The present invention seeks to reduce the above-described difficulties accompanying a conventional limit switch. More specifically, a preferable aim of the invention is to provide a limit switch which, when compared with the conventional one, is simple in construction, small in the number of components, small in size, and long in service life, and which operates satisfactorily at all times.

The foregoing aim of the invention is achieved by the provision of a limit switch which, according to the invention, comprises: a rotational operation section including a rotary shaft rotatably supported on a housing and an actuator for turning the rotary shaft; a switch section provided below the rotational operation section, and wherein the rotational operation section is associated with the switch section without providing a plunger between the rotational operation section and the switch section.

In the limit switch of the invention, the rotational motion of the rotary shaft is directly detected by the detector to perform switch operation. The switch operation may be performed directly by the rotational motion of the rotary shaft. Therefore, it is unnecessary for the limit switch to employ the mechanism which converts the rotational motion of the actuator into a linear motion. Hence, the limit

switch of the invention, when compared with the conventional one, is small in the number of components, and it can be miniaturized accordingly. In addition, in the limit switch of the invention, the rotational operation section is not in contact with the switch section, and therefore the limit switch is free from unreasonable stress, which increases the service life.

Furthermore, the housing of the limit switch is made up of the switch housing and the head housing which are formed as one unit. Therefore, a sealing structure can be readily formed without provision of an elastic seal member between the two housings. In addition, the limit switch includes no mechanism for converting rotational motion into linear motion, which eliminates the difficulty that the space in the switch housing changes in volume and in pressure. Therefore, the unsatisfactory operation due to the unsteady returning operation of the actuator can be eliminated; that is, the switching operation can be improved in response characteristic.

In the accompanying drawings:

FIG. 1 is an exploded perspective view showing the arrangement of a first embodiment of this invention;

FIG. 2 is a front view, with parts cut away, showing essential components of the first embodiment;

FIG. 3 is a side view, with parts cut away, showing essential components of the first embodiment;

FIG. 4 is an enlarged sectional view showing essential components of the first embodiment;

FIG. 5 is a side view, with parts cut away, showing essential components of a second embodiment of the invention;

FIG. 6 is an enlarged perspective view showing essential components of the second embodiment;

FIG. 7 is a side view, with parts cut away, showing essential components of a third embodiment of the invention;

FIG. 8 is a front view, with parts cut away, showing essential components of a fourth embodiment of the invention;

Fig. 9 is a side view, with parts cut away, showing essential components of a sixth embodiment of the invention;

Fig. 10 is a front view, with parts cut away, showing essential components of the sixth embodiment;

Fig. 11 is a front view, with parts cut away, showing essential components of a seventh embodiment of the invention;

Fig. 12 is an exploded perspective view showing the arrangement of an eighth embodiment of the invention;

Fig. 13 is a side view, with parts cut away, showing essential components of the eighth embodiment;

Fig. 14 is a front view, with parts cut away, showing essential components of the eighth embodiment;

Fig. 15 is an exploded perspective view showing the arrangement of a ninth embodiment of the invention;

Fig. 16 is a side view, with parts cut away, showing essential components of the ninth embodiment;

Fig. 17 is a front view, with parts cut away, showing essential component of the ninth embodiment;

Fig. 18A is an enlarged perspective view showing a swingable lever in the ninth embodiment;

Fig. 18B is an enlarged perspective view showing a swingable lever in a tenth embodiment of the present invention;

Fig. 19 is a front view, with parts cut away, showing essential components of the tenth embodiment;

Fig. 20 is a side view, with parts cut away, showing essential components of the tenth embodiment;

Fig. 21 is a perspective view showing another example of the swingable lever used in the ninth embodiment;

Fig. 22 is a perspective view showing another example of the swingable lever used in the tenth embodiment;

Fig. 23 is a front view, with parts cut away, showing essential components of an eleventh embodiment of the invention; and

FIG. 24 is a side view showing essential components of a conventional limit switch.

Preferred embodiments of this invention will be described by way of example, with reference to the accompanying drawings.

First Embodiment:

FIGS. 1 to 4 show an example of a limit switch, which constitutes a first embodiment of the invention.

In FIG. 1, parts equal to or corresponding functionally to those which have been described with reference to FIG. 24 are therefore designated by the same reference numerals or characters.

As shown in FIG. 1, the limit switch comprises: a housing A; a rotational operation section B mounted in the upper portion of the housing A; and a switch section C provided in the lower portion of the housing A.

The housing A, as shown in FIGS. 2 and 3, comprises: a tubular switch housing 3; and a head

housing 5 which is integral with one end opening 3b of the housing 3. A shaft hole 6 is formed in one side of thee head housing 5, into which a rotary shaft 9 is inserted. The rotary shaft 9 is rotatably fitted through an O-ring 8 in the shaft hole 6 of the head housing 5 in such a manner that one end portion 9a of the rotary shaft 9 is extended outside the head housing 5. An actuator 10 together with a spacer 55 is mounted on the one end portion 9a of the rotary shaft in such a manner that the spacer 55 is located between the actuator and the head housing. The actuator thus mounted is fixed with a screw 11. The actuator 10 includes a shaft member 13, on which a roller 12 is mounted.

The other end portion 9b of the rotary shaft 9 is inserted into a cam 25. The cam 25 comprises: a boss 25b defining a shaft hole 25a into which the other end portion 9b of the rotary shaft 9 is inserted; an arcuate spring-receiving protrusion 25c which is coaxial with the boss 25b and radially spaced a predetermined distance from the latter 25b; and a cam protrusion 25d protruded radially from the outer cylindrical wall of the boss 25b. A pair of electrically conductive parts 27a and 27b which is to be detected (hereinafter referred to as "particular detection parts 27a and 27b", when applicable) are mounted on the outer cylindrical surface of the cam protrusion 25d in such a manner that they are circumferentially spaced a predetermined distance from each other.

A return spring 26, which is a coiled spring, is coaxially wounded on the boss 25b of the cam 25 with its two ends engaged with locking grooves formed in the inner surface of the head housing 5. That is, the return spring 26 is elastically interposed between the inner surface of the head housing 5 and the cam 25 to give a rotational return force to the rotary shaft 9 and hold the latter 9 in neutral position.

The aforementioned switch section C is made up of a proximity switch. The proximity switch comprises: a switch casing 28; a detector 29 mounted on the inner surface of the casing 28; and a printed circuit board 30 on which predetermined electrical circuit elements such as an oscillation circuit and a signal processing circuit have been mounted.

Electrical elements forming the electrical circuit, and operation indicating light-emitting elements 54 are mounted on the printed circuit board 30. Lead wires 31 connected to the lead pattern of the printed circuit board are connected to a connector 37 mounted on a cover 36, so that they are extended outside the switch housing 3 through the lower end opening 3c.

The switch housing 3 is filled with synthetic resin 38 which is an electrically insulating material, so that the detector 29, the printed circuit board 30, etc. are molded with the resin.

The detector 29, as shown in FIG. 4, comprises: a coil spool 41 on which a detecting coil 42 has been wound; and a core 43 of magnetic material having an annular recess 43a, the core 43 being combined with the coil spool 41.

More specifically, the detecting coil 42 wound on the coil spool 4 is fitted in the annular recess 43a of the core 43. The leaders 42a of the coil 42 are electrically connected to predetermined electrical circuit elements, such as the aforementioned oscillation circuit and signal processing circuit, on the printed circuit board 30.

The operation of the limit switch thus organized will be described.

When a moving object abuts against the roller 12, the actuator 10 is turned clockwise or counterclockwise (in the direction of the arrow b or in the direction of the arrow a in FIG. 2), and accordingly the rotary shaft 9 together with the cam 25 is turned in the same direction.

As the cam 25 is turned in this way, one of the detecting parts 27a and 27b on the cam 25 approaches the detecting coil 42, thereby to change the inductance of the latter 42. The change in inductance is detected by the oscillation circuit, so that the latter outputs a detection signal through the signal processing circuit. This detection signal is applied to the light emitting elements 54 so that this detecting operation can be visually confirmed with the aid of the light emitting elements 54.

In the limit switch, rotation of the rotary shaft 9 directly operates the proximity switch. This means that the limit switch can be formed without the mechanism which converts the rotational motion of the actuator 10 into a linear motion. Hence, the limit switch of the invention, when compared with the conventional one, is small in the number of components, and it can be miniaturized accordingly. In addition, in the limit switch of the invention, the rotational operation section B is not in contact with the switch section C, and therefore the limit switch is free from unreasonable stress, which lengthens the service life.

Furthermore, in the limit switch, the housing A is made up of the switch housing 3 and the head housing 5 which are formed as one unit. Therefore, a sealing structure can be readily formed without provision of an elastic seal member between the housings 3 and 5. The sealing effect can be improved much by filling the switch housing 3 with synthetic resin 38 through the end opening 3c in such a manner as to resin-mold the electrical elements therein.

In addition, the limit switch includes no mechanism for converting rotational motion into linear motion, which eliminates the difficulty that the space in the switch housing changes in volume and

in pressure. Therefore, the unsatisfactory operation is eliminated which is due to the unsteady returning operation of the actuator; that is, the switching operation is improved in response characteristic.

Second Embodiment:

In the above-described first embodiment, the switch section C is the proximity switch. However, the switch section C may be made up of a light-transmission type photo-electric switch as shown in FIGS. 5 and 6.

The photo-electric switch comprises: a switch casing 28 having a U-shaped recess 28a; and a detector 29 including a light emitting element 47 and a light receiving element 48. Those elements 47 and 48 are arranged in the switch casing 28 in such a manner that they are confronted with each other, so that, as shown in FIG. 6, a light beam 60 outputted by the light emitting element 47 is applied to the light receiving element 48 through through-holes 49 and 50 formed in the casing 28.

A light intercepting board 46 adapted to intercept the light beam 60 is rotatably provided in the above-described recess 28a. The light intercepting board 46 is extended from the cam 25 fixedly mounted on the other end portion 9b of the rotary shaft 9, and has a pair of through-holes 46a and 46b which are formed in it with a predetermined angular interval therebetween.

When a moving object abuts against the roller 12, the actuator 10 together with the light intercepting board 42 is turned clockwise or counterclockwise (in the direction of the arrow b or in the direction of arrow a in FIG. 6), so that the light beam 60 is applied through one of the through-holes 46a and 46b to the light receiving element 48. The output signal of the light receiving element 48 is processed by the signal processing circuit on the printed circuit board, to provide a detection signal.

Third Embodiment:

The above-described switch section C may be made up of a detector 29 which, as shown in FIG. 7, includes a magneto-electric conversion element 52, such as a Hall element, provided on the printed circuit board 30.

That is, the magneto-electric conversion element 52 is built in the switch casing 28, and a magnet 51 for applying magnetic flux to the magneto-electric conversion element 51 is provided on the cam 25 which is fixedly mounted on the other end portion of the rotary shaft 9.

When a moving object abuts against the roller 12, the actuator 10 together with the magnet 51 is turned. As a result, the electro-magnetic conversion element 52 is activated, so that a detection signal is provided with the aid of the signal procesing circuit on the printed circuit board 30.

Fourth Embodiment:

The above-described limit switch may be so modified that, as shown in FIG. 8, the roller 12 is pushed by a dog D.

In the fourth embodiment using the dog D to push the roller 12, the switch section C is made up of a proximity switch similarly as in the first embodiment. However, it goes without saying that the above-described photo-electric switch or magneto-electric conversion switch may be employed.

Fifth Embodiment:

Each of the above-described embodiments may be modified as follows: A side opening (not shown), which is similar to the side opening 3a of the conventional limit switch shown in FIG. 24, is formed in one side of the switch housing 3, and it is closed with a cover. The fifth embodiment has the same effects as the first through fourth embodiments.

Sixth Embodiment:

FIGS. 9 and 10 show an example of a limit switch, which constitutes a sixth embodiment of the present invention.

As shown in FIG. 9, the limit switch comprises: a housing A; a rotational operation section B mounted in the upper portion of the housing A; and a switch section C provided in the lower portion of the housing A.

The housing A comprises: a tubular switch housing 103; and a head housing 105 which is integral with one end opening 103b of the housing 103. A shaft hole 106 is formed in one side of thee head housing 105, into which a rotary shaft 109 is inserted. The rotary shaft 109 is rotatably fitted through an O-ring 108 in the shaft hole 106 of the head housing 105 in such a manner that one end portion 109a of the rotary shaft 109 is extended outside the head housing 105. An actuator 110 is mounted on and fixed to the one end portion 109a Of the rotary shaft. The actuator 110 includes a shaft member 113, on which a roller 112 is mounted.

The other end portion 109b of the rotary shaft 109 is inserted into a cam 125. The cam 125 comprises: a boss 125b defining a shaft hole 125a into which the other end portion 109b of the rotary shaft 9 is inserted; an arcuate spring-receiving protrusion 125c which is coaxial with the boss 125b and radially spaced a predetermined distance from

the latter 125b; and a cam protrusion 125d protruded radially from the outer cylindrical wall of the boss 125b. As shown in Fig. 10, a pair of magnetic elements 126a and 126b are mounted on the outer cylindrical surface of the cam protrusion 125d in such a manner that they are circumferentially spaced a predetermined distance from each other.

A return spring 127, which is a coiled spring, is coaxially wounded on the boss 125b of the cam 125 with its two ends engaged with locking grooves formed in the inner surface of the head housing 105. That is, the return spring 127 is elastically interposed between the inner surface of the head housing 105 and the cam 125 to give a rotational return force to the rotary shaft 109 and hold the latter 109 in neutral position.

The switch section C comprises a switch case 128, a terminal base 129 fittingly mounted onto a lower opening portion 128a of the switch case 128, and a contact mechanism 130 mounted on the base 129.

The switch mechanism 130 includes fixed terminals 132 and 133 respectively formed with fixed contacts 131a and 131b and a common terminal 135 on which a movable contact piece 134 is fixed. The movable contact piece 134 is arranged such that a movable contact 136 provided on the contact piece 134 is confronted with the fixed contacts 131a and 131b. The movable contact 136 can be brought in contact with each of the fixed contact 131a and 131b. A magnet 137 is fixed onto the movable contact piece 134 so as to be confronted with an outer cylindrical surface of the cam protrusion 125d of the cam 125.

The switch section C is electrically connected to a printed circuit board on which predetermined electrical circuit elements such as a signal processing circuit or the like has been mounted.

Electrical elements 139 forming the electrical circuit, and operation indicating light-emitting elements 140 are mounted onto the printed circuit board 138 connected to lead wires of cable 141 extending outside the switch housing 103.

The switch housing 103 is filled with synthetic resin 143 (as indicated by x) which is an electrically insulating material, so that portions of terminals 132, 133 and 135 extending downward from the terminal base 129 are molded with the resin. A cover 144 is fittingly secured to the lower opening portion 103c of the switch housing 103.

The operation of the limit switch thus organized will be described.

When a moving object abuts against the roller 112, the actuator 110 is turned clockwise or counterclockwise (in the direction of the arrow b or in the direction of the arrow a in FIG. 10), and accordingly the rotary shaft 109 together with the cam 125 is turned in the same direction.

As the cam 125 is turned in this way, one of the magnetic elements 126a and 126b on the cam 125 approaches the magnet 137, thereby to deflect the movable contact piece 134 by the virtue of mutual magnetic attraction force therebetween. Accordingly, the contact mechanism 130 is operated to be opened or closed so as to output a detection signal through the signal processing circuit. This detection signal is also applied to the light emitting elements 140 so that this detecting operation can be visually confirmed with the aid of the light emitting elements 140.

In the limit switch, rotation of the rotary shaft 109 directly operates the switch section C. This means that the limit switch can be formed without the mechanism which converts the rotational motion of the actuator 110 into a linear motion. Hence, the limit switch of the invention, when compared with the conventional one, is small in the number of components, and it can be miniaturized accordingly. In addition, in the limit switch of the invention, the rotational operation section B is not in contact with the switch section C, and therefore the limit switch is free from unreasonable stress, which lengthens the service life.

Furthermore, in the limit switch, the housing A is made up of the switch housing 103 and the head housing 105 which are formed as one unit. Therefore, a sealing structure can be readily formed without provision of an elastic seal member between the housings 103 and 105. The sealing effect can be improved much by filling the switch housing 103 with synthetic resin 143 through the end opening 103c in such a manner as to resin-mold the terminal portions of the switch section C therein.

In addition, the limit switch includes no mechanism for converting rotational motion into linear motion, which eliminates the difficulty that the space in the switch housing changes in volume and in pressure. Therefore, the unsatisfactory operation is eliminated which is due to the unsteady returning operation of the actuator; that is, the switching operation is improved in response characteristic.

Moreover, the aforementioned switch mechanism 130 have a contact switch construction with the movable contact piece 134, so that high-current flow/interrupt operation can be achieved.

In addition, in the sixth embodiment, a magnet which is attracted to or repulsed against the magnet 137 may be used in place of each of magnetic member 126a and 126b. In this case, the magnet 137 may be replaced with a magnetic member.

The above-described embodiments may be modified as follows: A side opening (not shown), which is similar to the side opening 3a of the conventional limit switch shown in FIG. 24, is formed in one side of the switch housing 103, and

it is closed with a cover.

Seventh Embodiment:

In the sixth embodiment, the contact mechanism 130 is arranged such that a movable contact piece 134 is extended in a longitudinal direction parallel to the rotary shaft 109. However, the movable contact piece 134 may be arranged to be extended in the longitudinal direction perpendicular to the rotary shaft 109 as shown in FIG. 11.

Eighth Embodiment:

FIGS. 12 to 14 show an eighth embodiment of the present invention. The basic construction of the eighth embodiment is similar to that of the aforementioned embodiments, so that only important or different portions thereof are described hereafter. In the eight embodiment, the cam protrusion is divided into two arc-shaped cam protrusions 225d and 225e each of which is protruded radially from the outer cylindrical wall of the boss 225b.

The switch section C is made up of a microswitch 228 having a contact mechanism operated to be opened and closed by depressing a pressure member 229. The contact mechanism (not shown) is installed in a switch case. Each mounting hole 231 formed in the switch case is fitted onto a corresponding projecting piece 230a provided on a switch holder 230 so that the microswitch 228 is held in place. The opening on one side of the holder 230 is closed by a cover 232. The switch holder 230 thus assembled with the microswitch 228 and the cover 232 is fixed to the switch housing 203 by caulking projections 203d projected from an inner wall of the switch housing 203 and inserted into respective mounting holes 230b.

The switch section C is electrically connected to a printed circuit board 233 on which an electrical element 234 forming predetermined circuit, an operation indicating light-emitting element 235 and so on are mounted.

When a moving object such as a dog D abuts against the rollers 212, the actuator 210 is turned clockwise or counterclockwise (in the direction of the arrow b or in the direction of the arrow a in Fig. 14), and accordingly the rotary shaft 209 together with the cam 225 is turned in the same direction.

As the cam 225 is turned in this way, one of cam protrusions 225d and 225e abuts against the pressure member 229 to open/close the contact mechanism in the microswitch case, so that a detection signal is output through the signal processing circuit. This detecting operation can be visually confirmed with the aid of the light emitting element to which the detection signal is applied.

Since the cam 225 in the rotational operation section B directly depresses the pressure member 229 of the microswitch 228, so that the limit switch is free from unreasonable stress, which lengthens the service life.

The above-described embodiment may be modified as follows: A side opening (not shown), which is similar to the side opening 3a of the conventional limit switch shown in FIG. 24, is formed in one side of the switch housing 203, and it is closed with a cover.

Ninth Embodiment:

FIGS. 15 to 18A show a ninth embodiment of the present invention. This embodiment is similar to the above-mentioned eighth embodiment, but is different therefrom in that a swingable lever 241 is provided between the cam 225 and the microswitch 228. The swingable lever 241 for depressing the pressure member 229 is fixed onto the switch housing 203 by caulking projections 203e provided on the inner wall of the switch housing 203 and inserted into respective mounting holes 41b shown in Fig. 18. The swingable lever 241 is provided at its distal end 41c with bearing pieces 41d on which a roller 43 is mounted through a pin 242.

When a moving object such as a dog D abuts against the rollers 212, the actuator 210 is turned clockwise or counterclockwise (in the direction of the arrow b or in the direction of the arrow a in Fig. 17), and accordingly the rotary shaft 209 together with the cam 225 is turned in the same direction.

As the cam 225 is turned in this way, one of cam protrusions 225d and 225e abuts against the roller 243, as a result of which the swingable lever 241 swingingly displaced to depress the pressure member 229 to open/close the contact mechanism in the microswitch case. Therefore, a detection signal is output through the signal processing circuit. This detecting operation can be visually confirmed with the aid of the light emitting element to which the detection signal is applied.

Since the cam 225 in the rotational operation section B with the aid of swingable lever 241 depresses the pressure member 229 of the microswitch 228, so that the limit switch is free from unreasonable stress, which lengthens the service life.

The above-described embodiment may be modified as follows: A side opening (not shown), which is similar to the side opening 3a of the conventional limit switch shown in FIG. 24, is formed in one side of the switch housing 203, and it is closed with a cover.

Tenth Embodiment:

In the aforementioned ninth embodiment, the swingable lever 241 is extended in the longitudinal direction perpendicular to the rotary shaft 209. However, as shown in Figs. 19 and 20, the swingable member 241 may be extended in the longitudinal direction parallel to the rotary shaft 209, provided that the roller 243 is mounted on the distal end 241c of the swingable lever 241 perpendicularly to the longitudinal direction of the swingable lever 241 as shown in Fig. 18B.

In addition, if the distal end of the swingable lever 241 is formed into a semicylindrical projection 241e, 241f as shown in Figs. 21 and 22, the roller 243 can be dispensed with.

Eleventh Embodiment:

In each of the ninth and tenth embodiments, a distal end 241a of the swingable lever 241 is fixed onto the inner wall of the switch housing 203, but it may be supported onto a microswitch case 228a as shown in Fig. 23. In this case, the swingable lever 241 may be formed as a separate member from the microswitch case 228a, or otherwise may be provided integrally with the microswitch case 228a.

As explained along various embodiments, in the limit switch of the invention, the rotational motion of the rotary shaft is directly detected by the detector to perform switch operation or the switch operation is performed directly by the rotational motion of the rotary shaft. Therefore, it is unnecessary for the limit switch to employ the mechanism which converts the rotational motion of the actuator into a linear motion. Hence, the limit switch described above when compared with the conventional one, is small in the number of components, and it can be miniaturized accordingly. In addition, when the limit switch is constructed such that the rotational operation section is not in contact with the switch section, the limit switch is free from unreasonable stress, which increases the service life. When the movable and fixed contact construction is utilized in the limit switch, the switch can perform the high-current flow/interrupt switch operation. Furthermore, the housing of the limit switch is made up of the switch housing and the head housing which are formed as one unit. Therefore, a sealing structure can be readily formed without provision of an elastic seal member between the two housings. In addition, the limit switch includes no mechanism for converting rotational motion into linear motion, which eliminates the difficulty that the space in the switch housing changes in volume and in pressure. Therefore, the unsatisfactory operation is eliminated which is due to the unsteady returning operation of the actuator; that is, the switching operation is improved in response characteristic.

Claims

1. A limit switch comprising:
   a rotational operation section including a rotary shaft rotatably supported on a housing and an actuator for turning said rotary shaft;
   a switch section provided below said rotational operation section, and wherein
   said rotational operation section is associated with said switch section without providing a plunger between said rotational operation section and said switch section.

2. The limit switch according to claim 1, wherein said switch section includes a microswitch installed accommodated within said housing and provided with a push button, and said rotational operation section further includes a cam provided on said rotary shaft for operating said push button in conjunction with the rotation of said rotary shaft.

3. The limit switch according to claim 1, wherein a cam having at least one particular detection part on an outer cylindrical surface thereof is mounted fixedly on said rotary shaft, and a detector is provided in said switch section for detecting said particular detection part to thereby provide a detection signal.

4. The limit switch according to claim 3, wherein said detector detects said particular detection part in non-contact with said particular detection part.

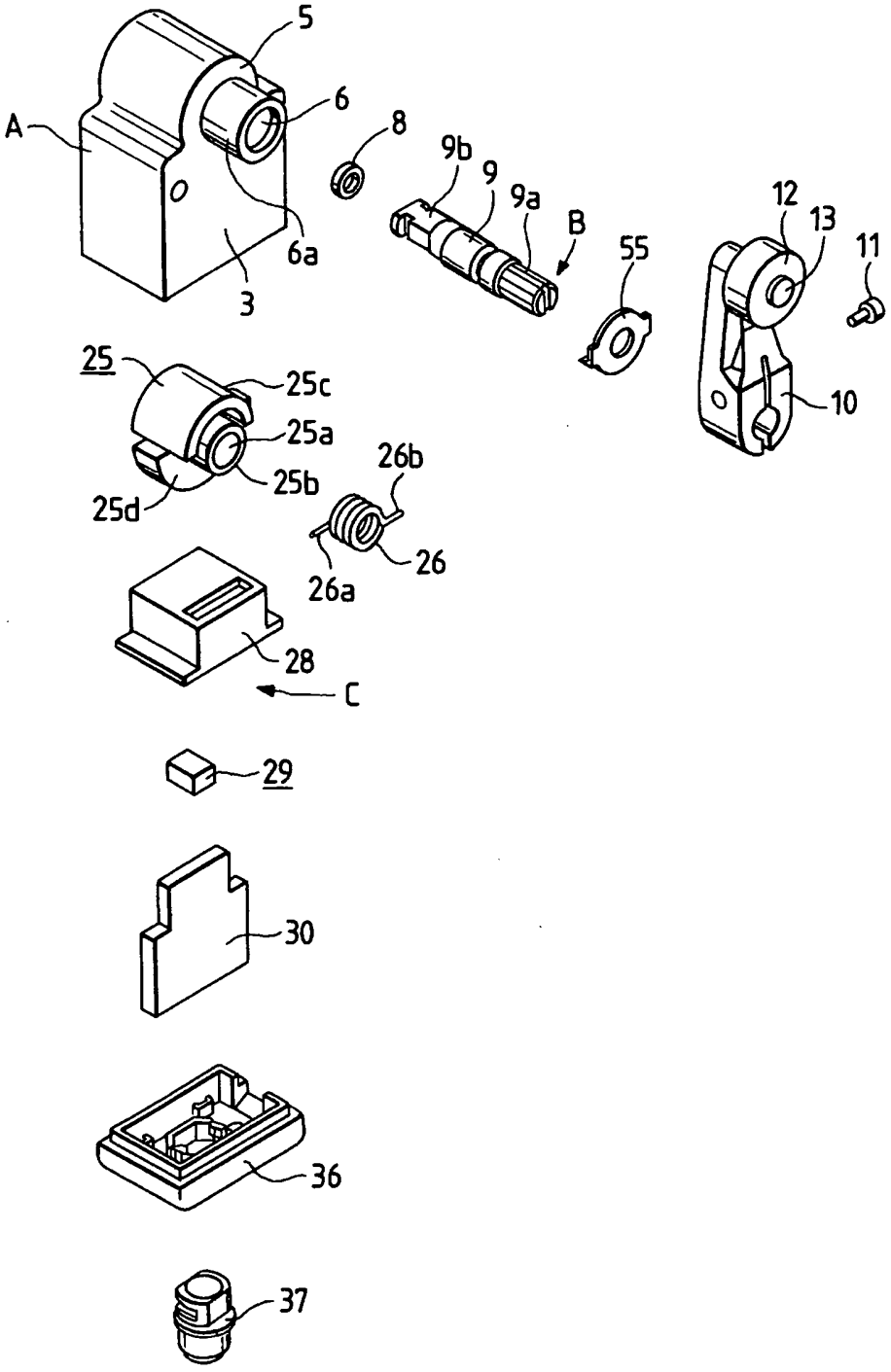
5. The limit switch according to claim 2, wherein a lever is fixed at one end thereof onto an inner wall of said housing such that a projection formed on the other end of said lever is interposed between said cam and said microswitch.

6. The limit switch according to claim 4, wherein said particular detection part is a permanent magnet and said detector includes a switch lever driven by said permanent magnet for switching a contact.

7. A limit switch comprising:
   a housing;
   a rotary shaft rotatably supported on said housing;
   an actuator mounted fixedly on said rotary shaft for rotating said rotary shaft; and

a switch section defined in said housing and provided with a switching mechanism; said switching mechanism being operated in conjunction with the rotational motion of said rotary shaft without converting the rotational motion into a linear motion.

FIG. 1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A
8
9b
9
9a
B
55
12
13
11
6a
3
25
25c
25a
25b
25d
26b
26
26a
10
28
C
29
30
36
37

FIG. 2

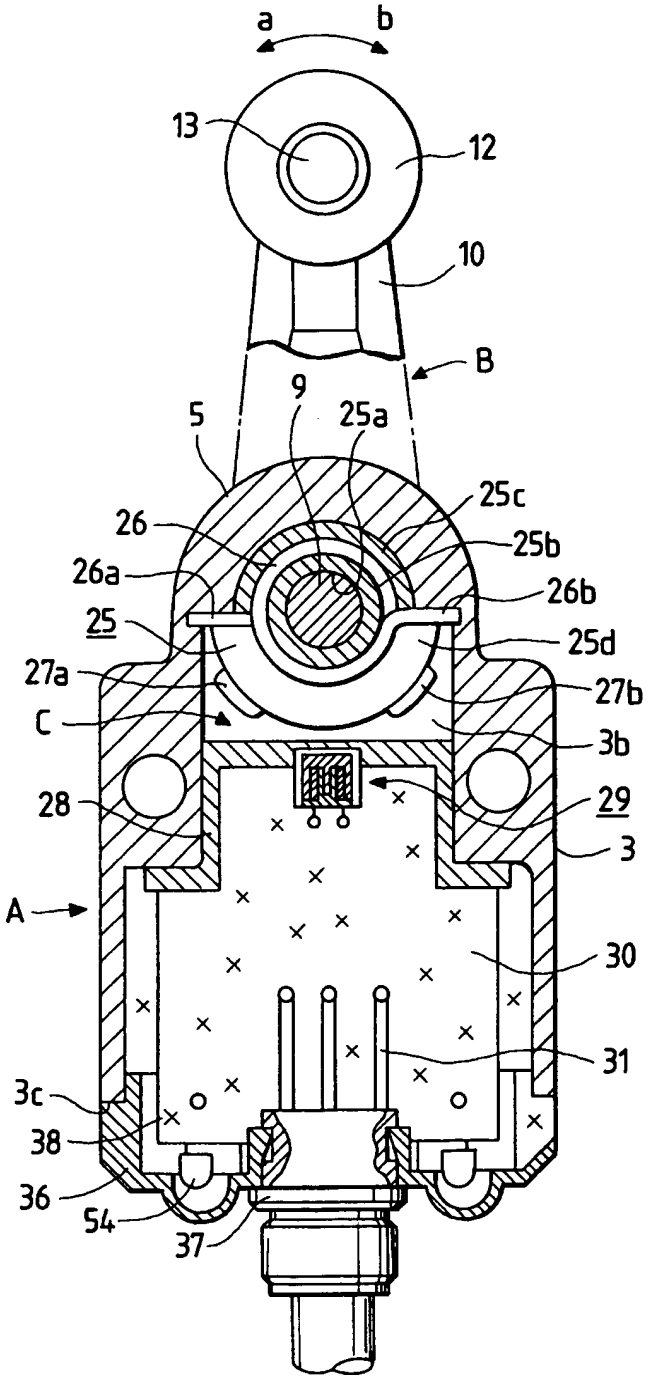

a
b
13
12
10
B
9
5
25a
25c
26
25b
26a
26b
25
25d
27a
27b
C
3b
28
29
3
A
30
31
3c
38
36
54
37

FIG. 3

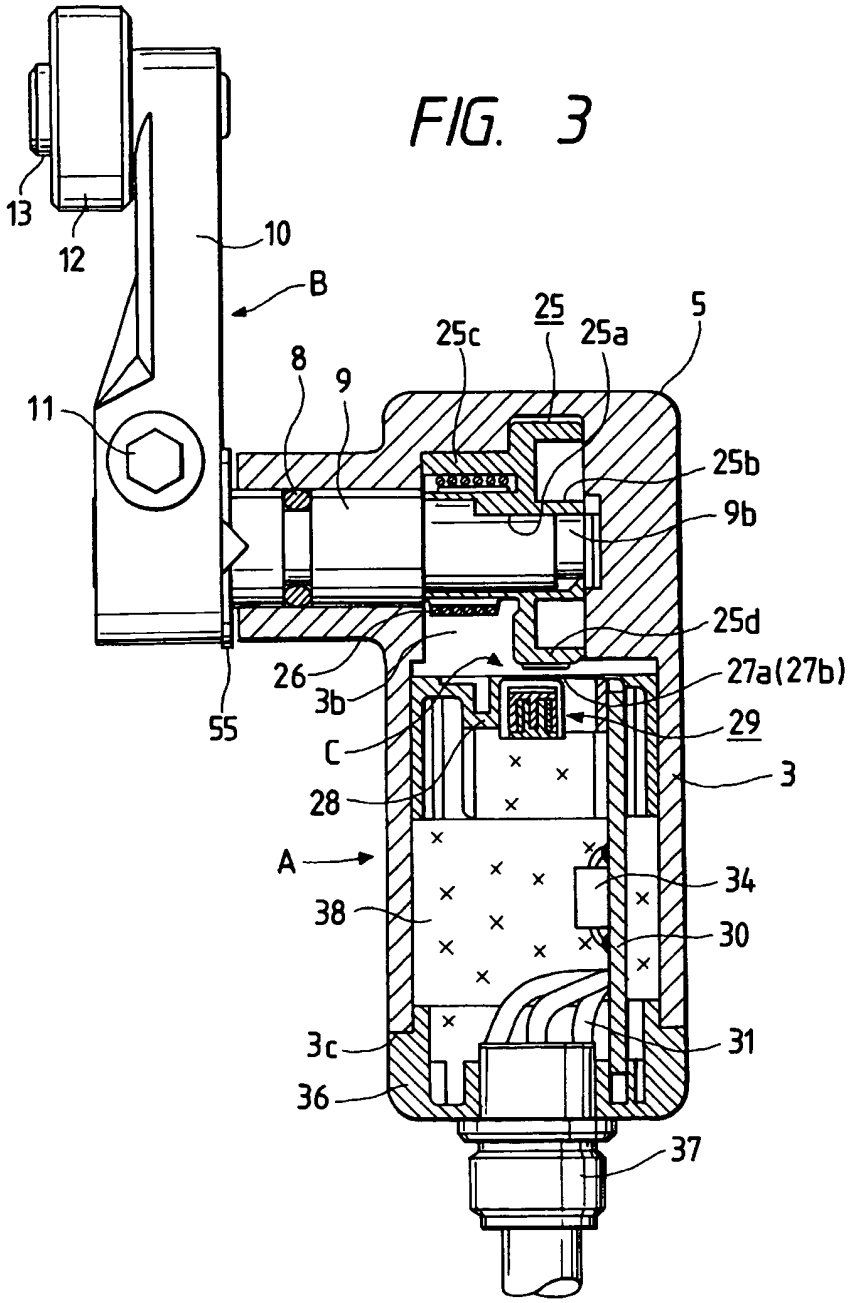
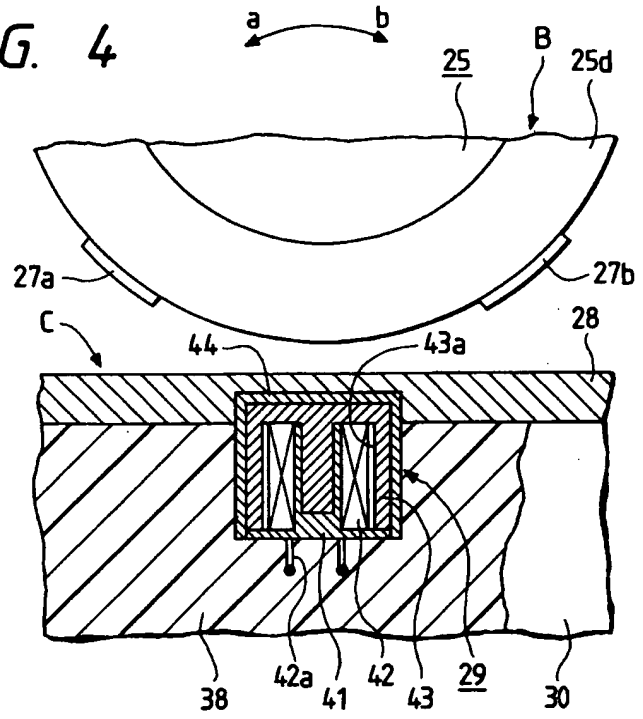

13
12
10
B
11
8
9
25c
25
25a
5
25b
9b
25d
26
3b
27a(27b)
55
C
29
3
28
A
34
38
30
3c
31
36
37

FIG. 4


a
b
25
B
25d
27a
27b
C
28
44
43a
38
42a
41
42
43
29
30

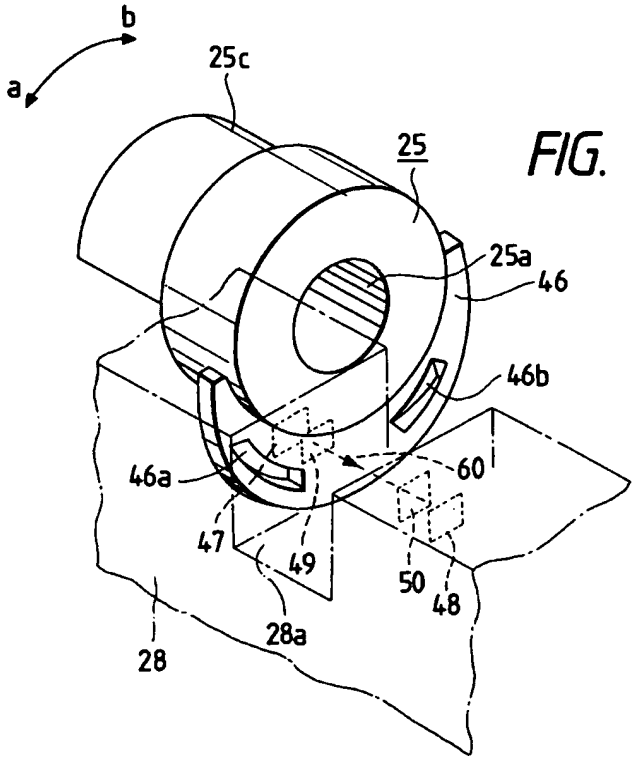

b
a
25c
25
25a
46
46b
46a
60
47
49
50
48
28a
28

FIG. 6

FIG. 5

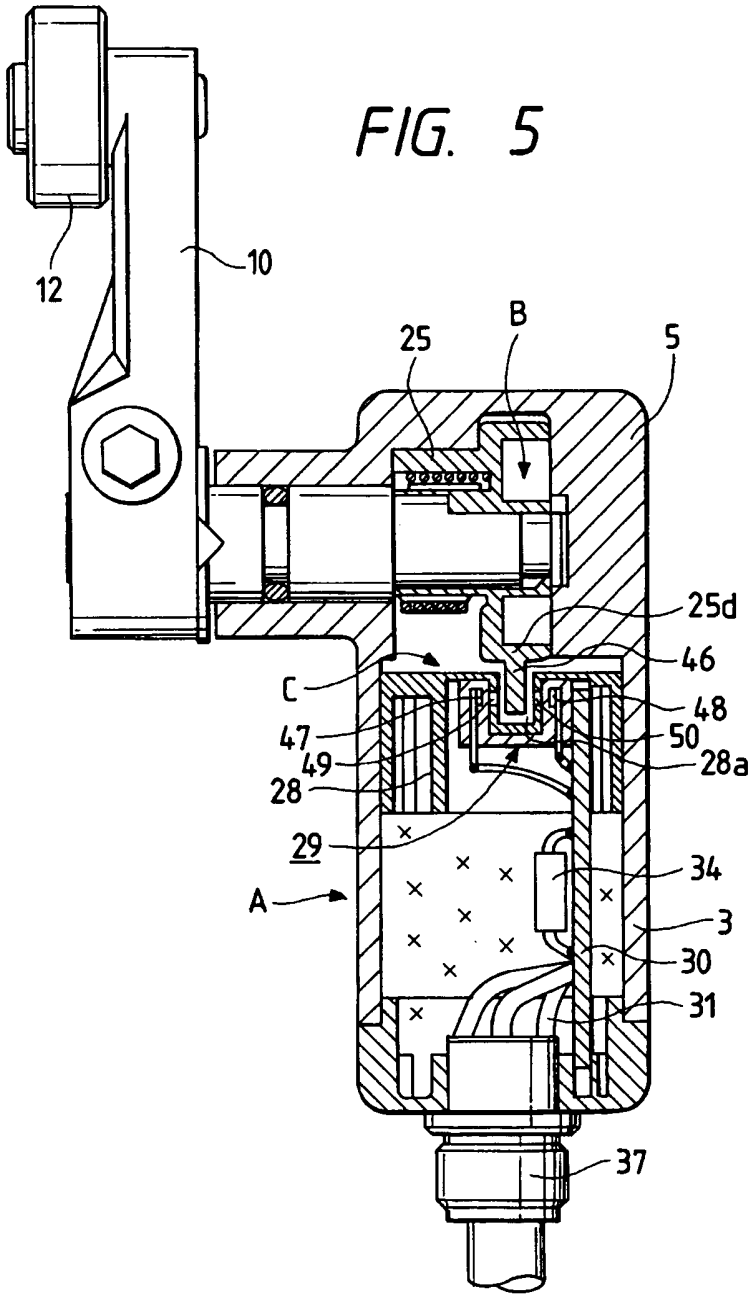


FIG. 7

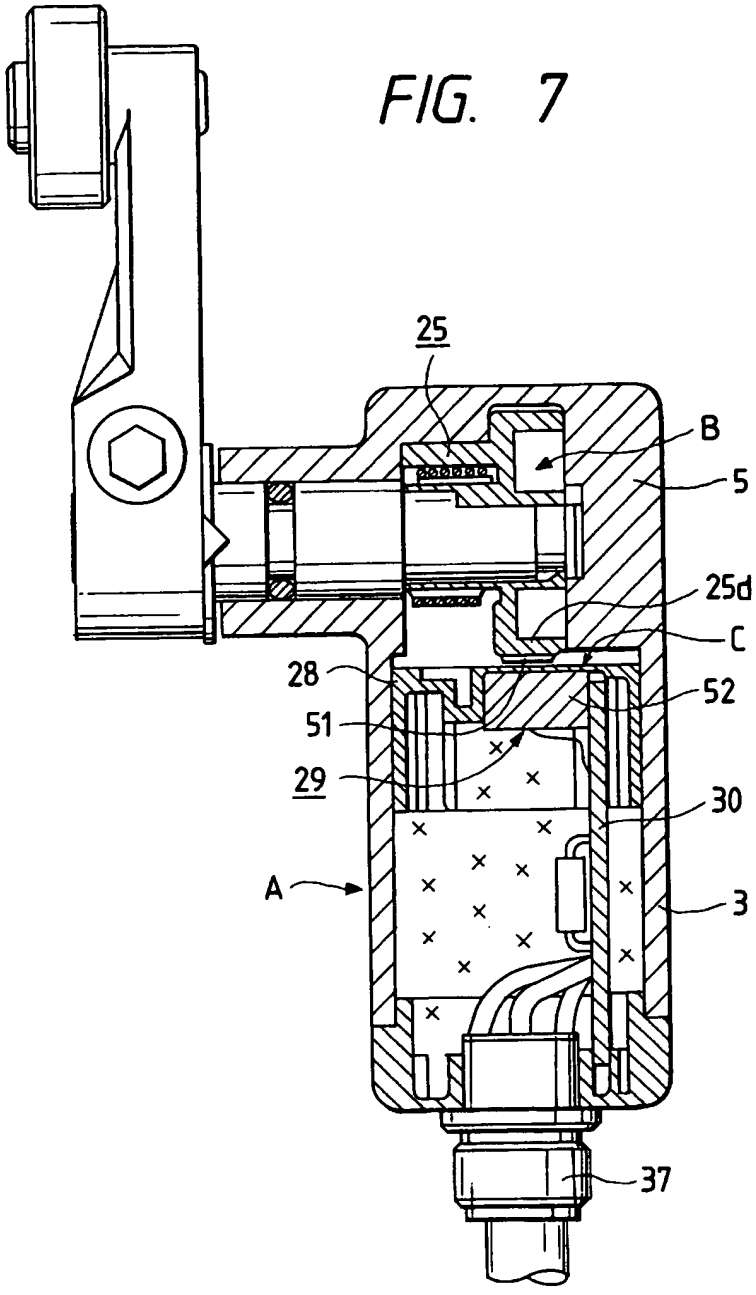


FIG. 8

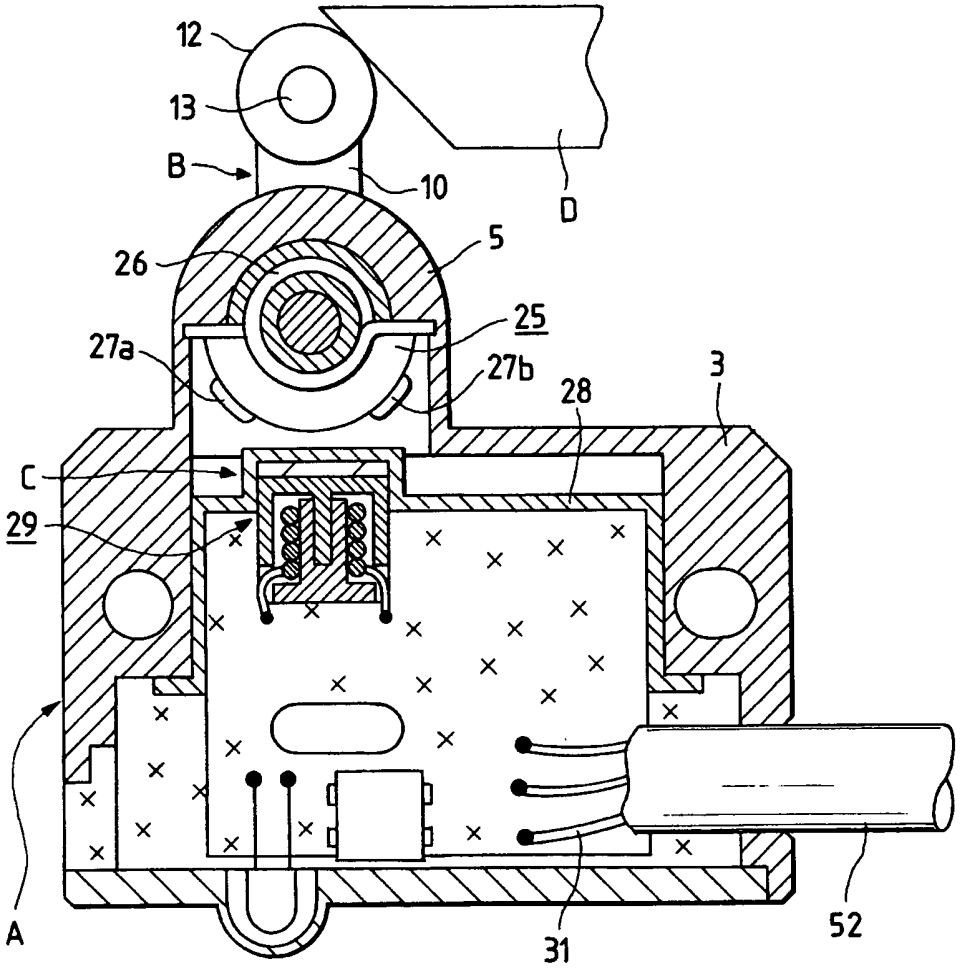


FIG. 9

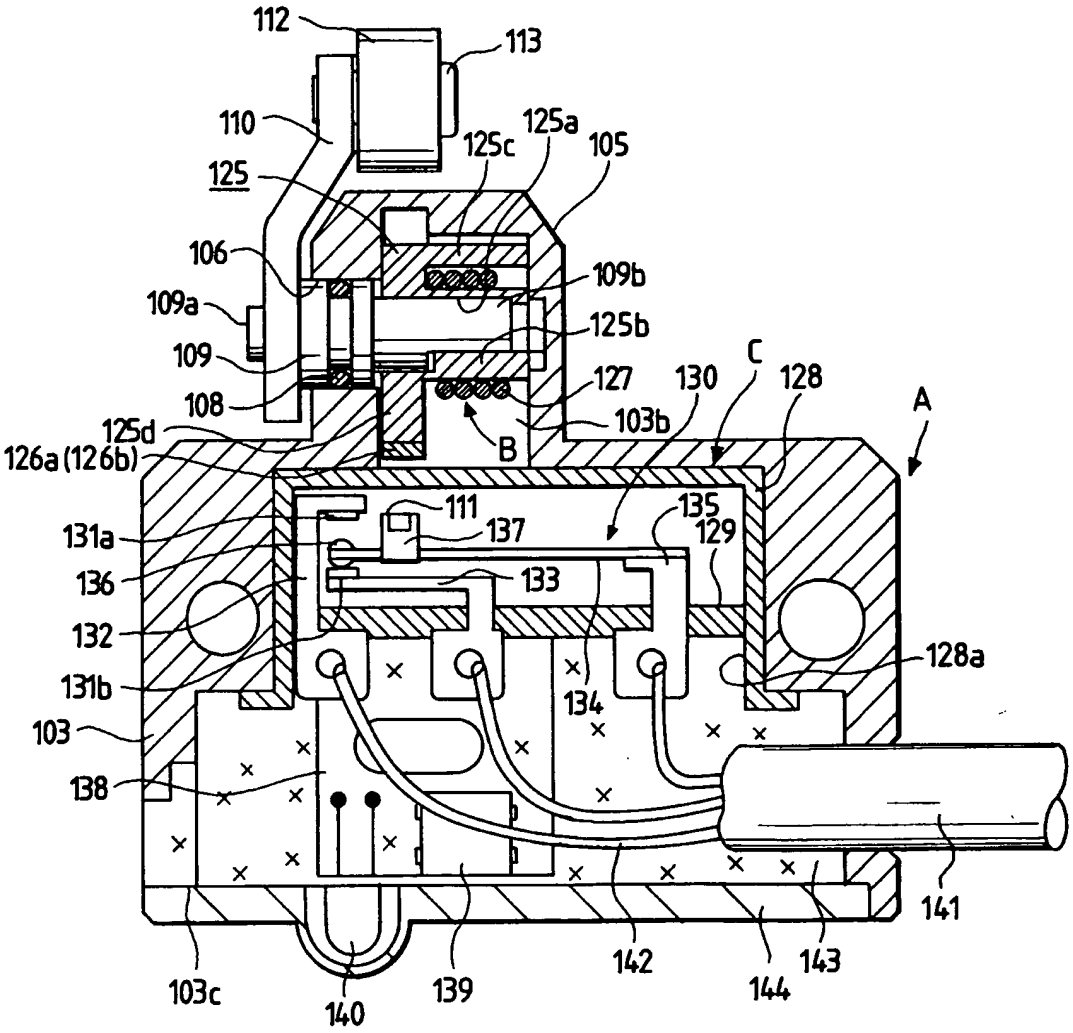

112
113
110
125c
125a
105
125
106
109b
109a
125b
109
127
130
C
128
A
108
103b
125d
B
126a (126b)
111
135
131a
137
129
136
133
132
128a
131b
134
103
138
141
103c
140
139
142
144
143

FIG. 10

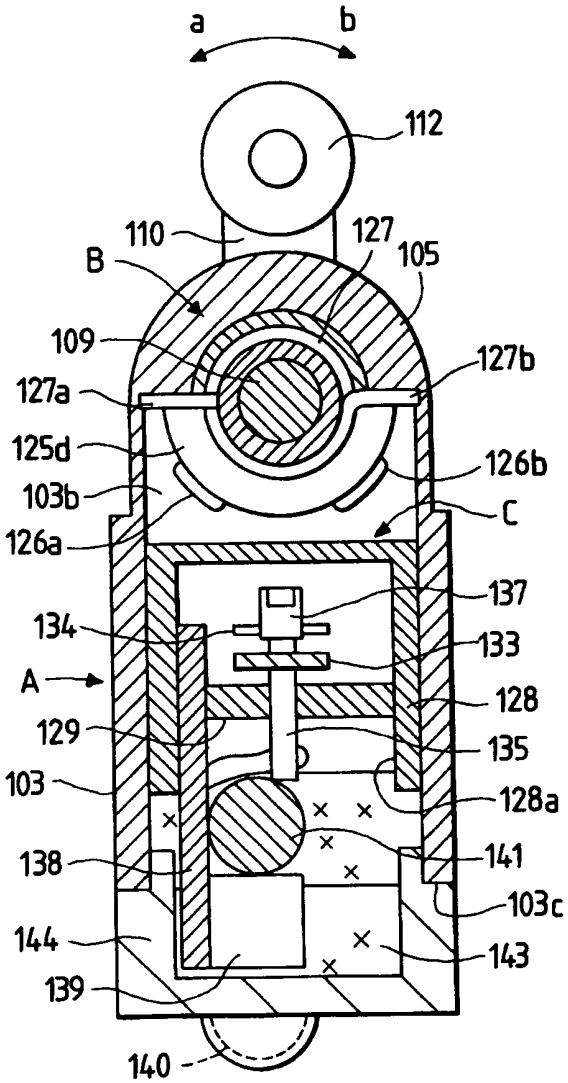

a
b
112
110
127
105
B
109
127b
127a
125d
126b
103b
C
126a
137
134
133
A
128
129
135
103
128a
138
141
103c
144
143
139
140

FIG. 11

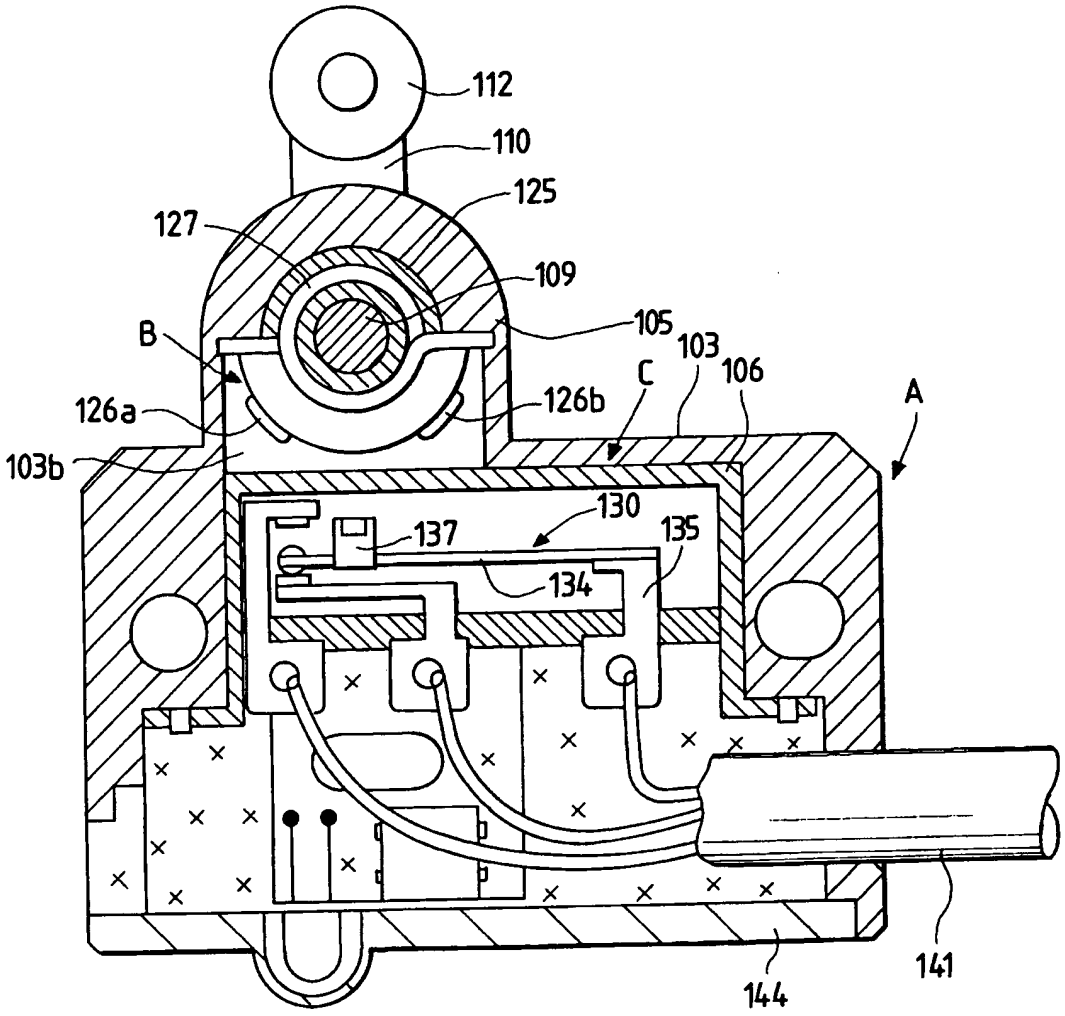

112
110
125
127
109
105
B
103
106
C
A
126a
126b
103b
130
137
135
134
144
141

FIG. 12

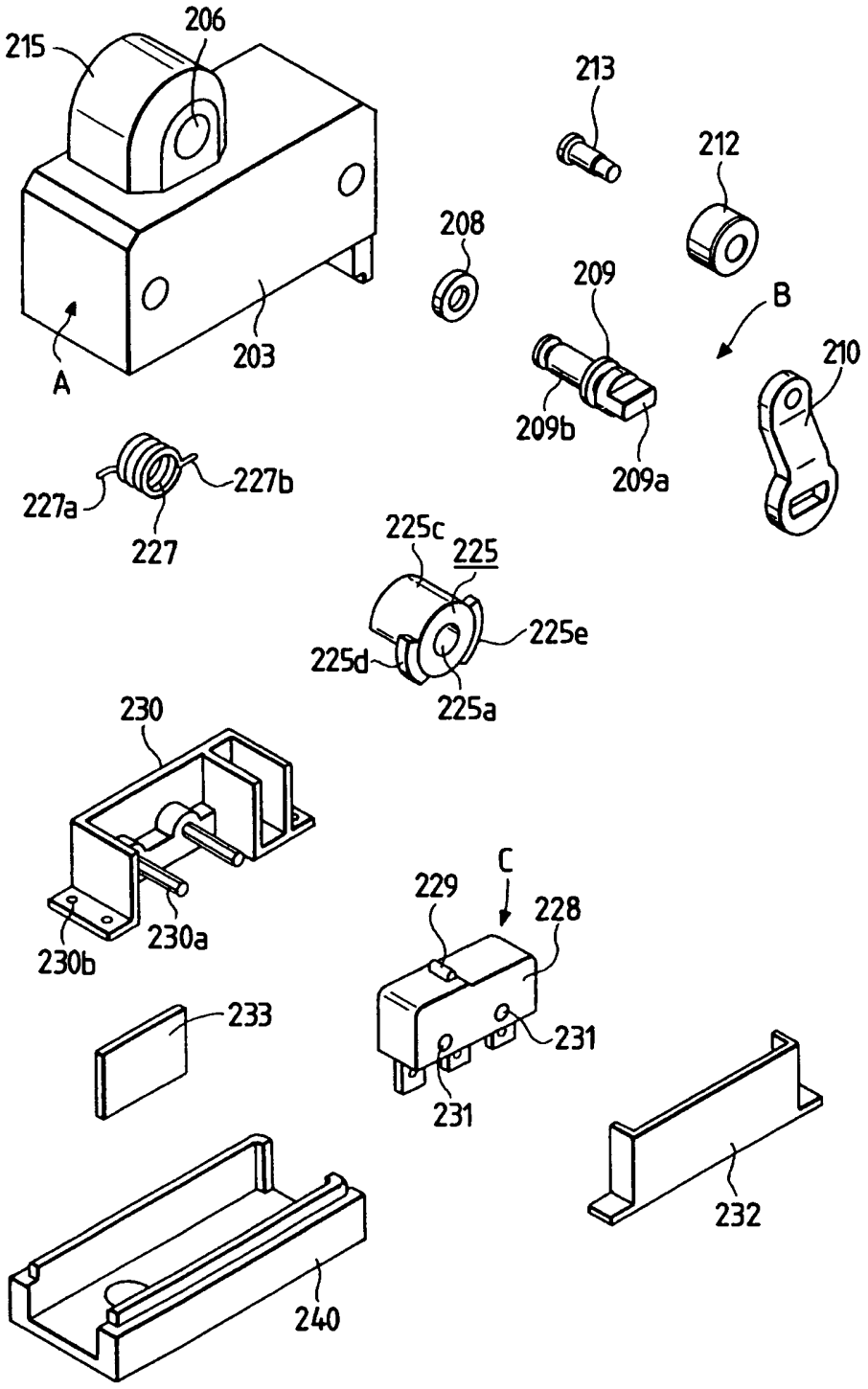

206
215
213
212
208
209
B
210
203
A
209b
209a
227a
227b
227
225c
225
225e
225d
225a
230
230a
230b
C
229
228
233
231
231
232
240

FIG. 13

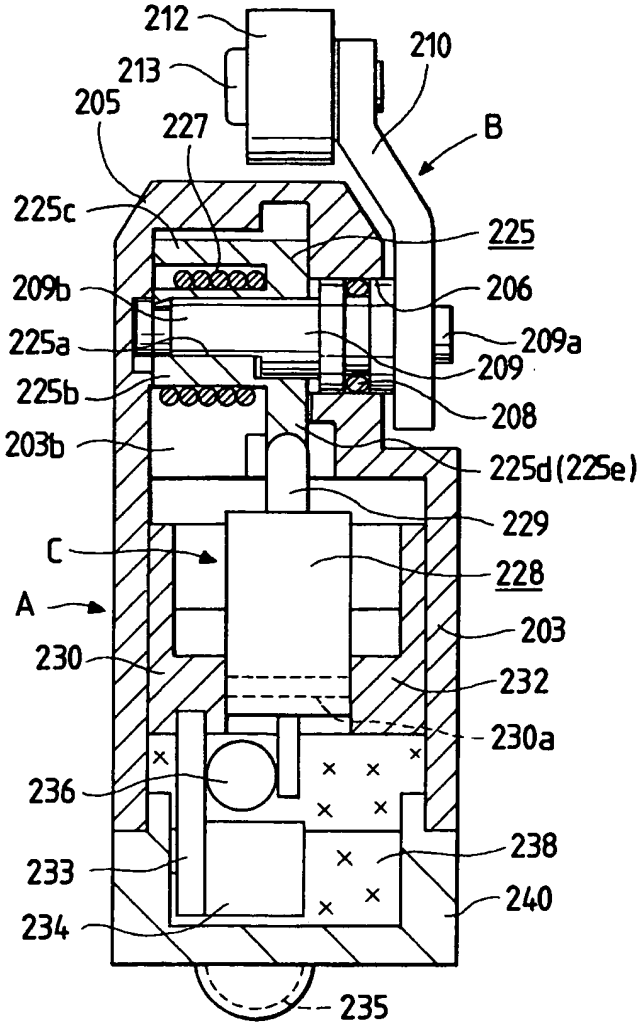

212
213
205
227
210
B
225c
225
209b
206
225a
209a
209
225b
208
203b
225d(225e)
229
C
228
A
203
230
232
230a
236
238
233
240
234
235

FIG. 14

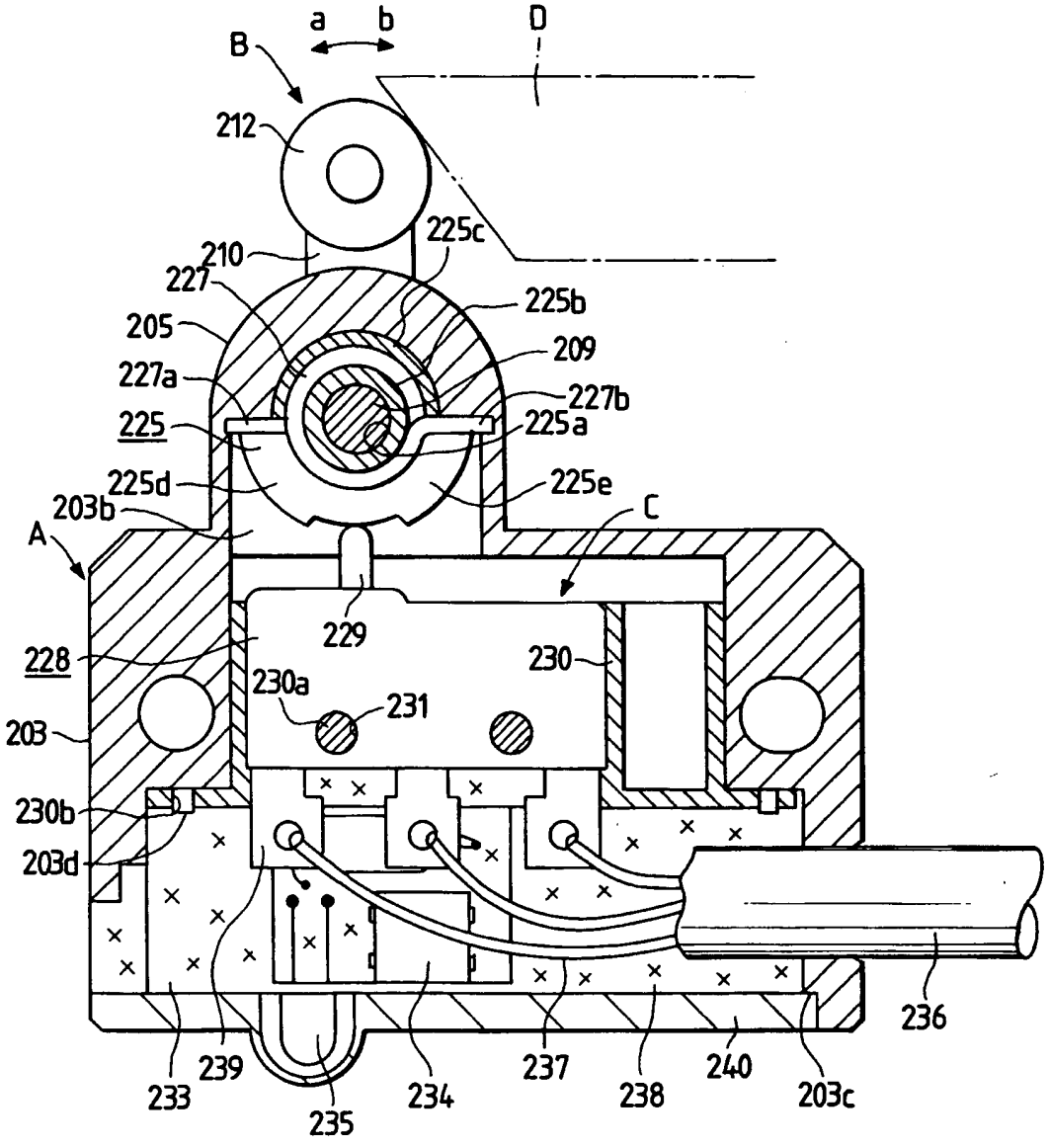

a
b
D
B
212
225c
210
227
225b
205
209
227a
227b
225
225a
225d
225e
203b
C
A
229
228
230
230a
231
203
230b
203d
236
233
239
234
237
238
240
203c
235

FIG. 15

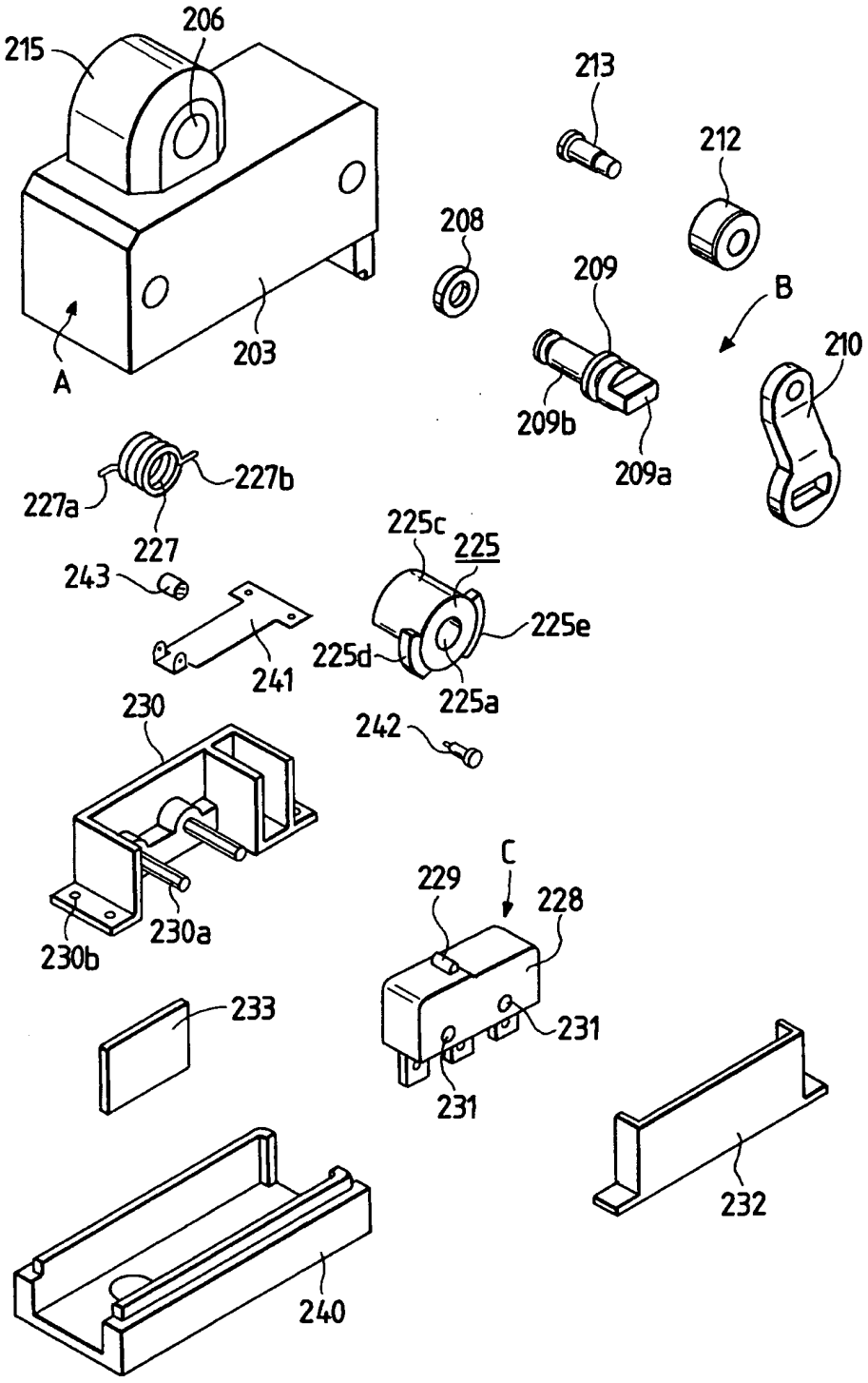

206
215
213
212
208
209
B
210
203
A
209b
209a
227b
227a
227
225c
225
243
225e
225d
241
225a
230
242
C
229
228
230a
230b
233
231
231
232
240

FIG. 16

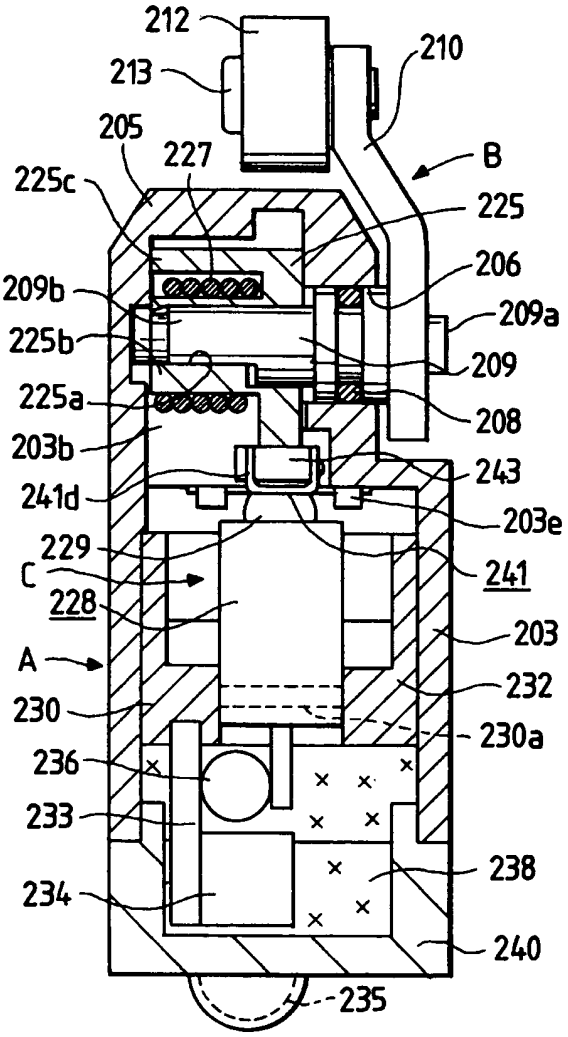

212
213
205
227
210
B
225c
225
206
209b
209a
225b
209
225a
208
203b
243
241d
203e
229
241
C
228
203
A
232
230
230a
236
233
238
234
240
235

FIG. 17

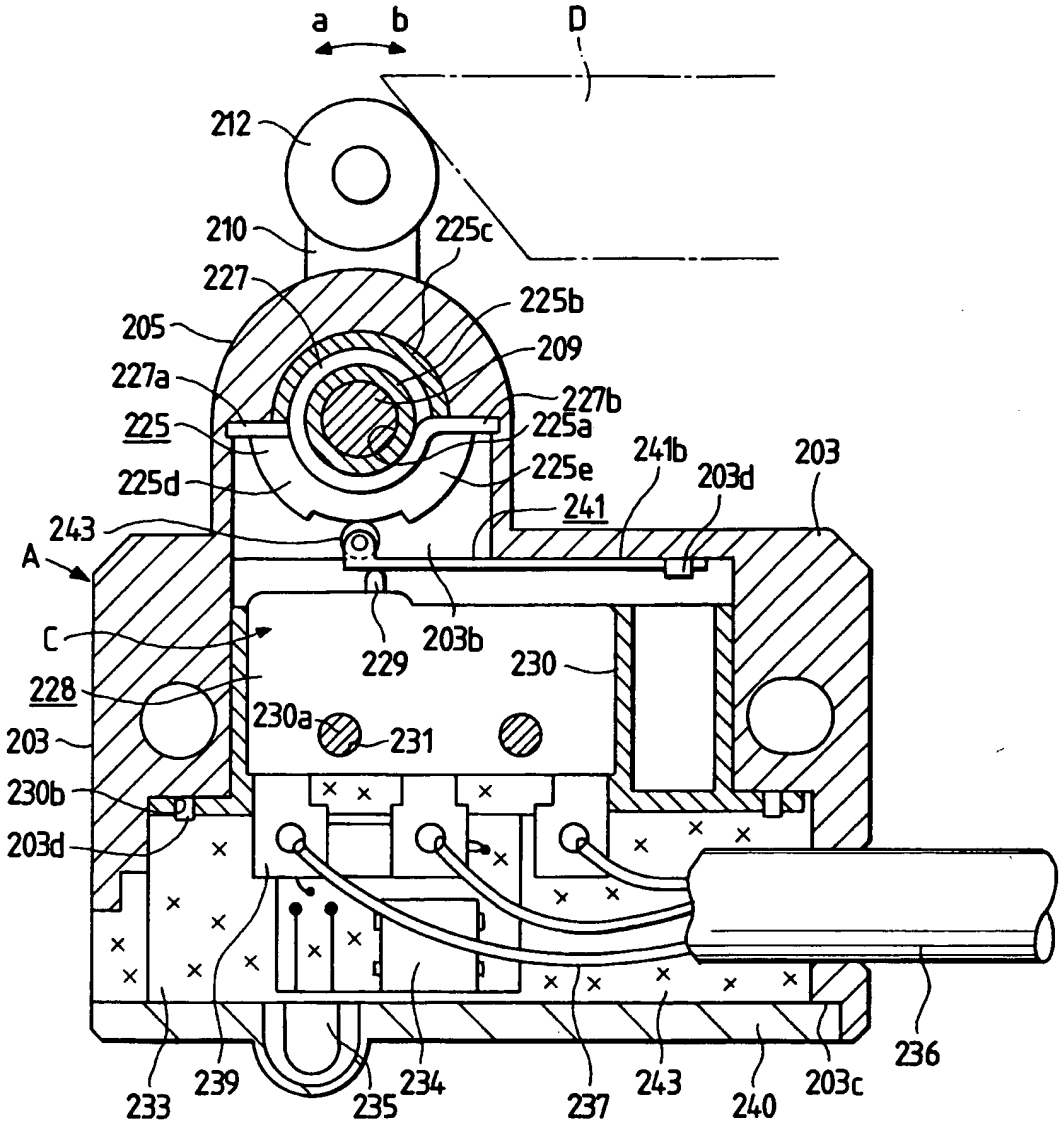

a
b
D
212
210
225c
227
225b
205
209
227a
227b
225
225a
225e
241b
203d
203
225d
241
243
A
C
229
203b
230
228
230a
231
203
230b
203d
233
239
235
234
237
243
240
203c
236

FIG. 18A

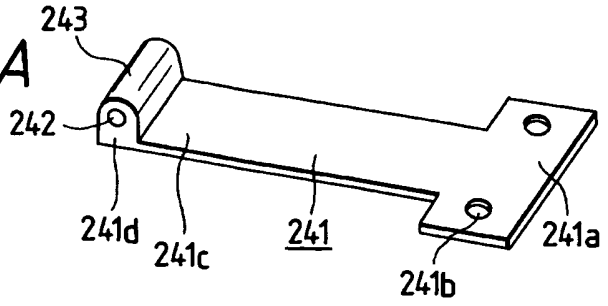


FIG. 18B

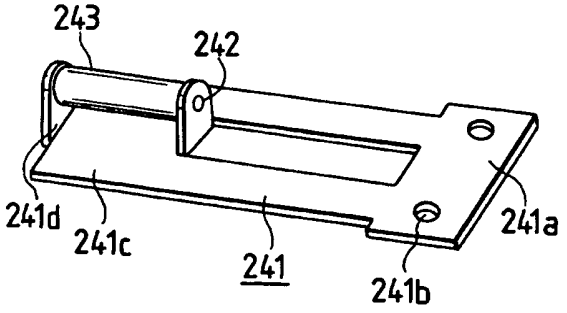


FIG. 21

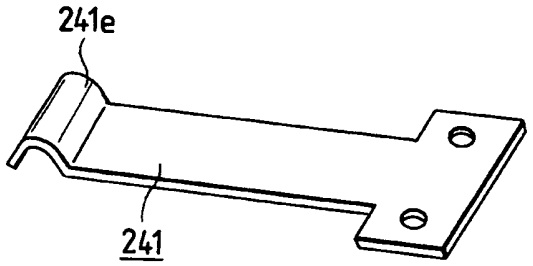


FIG. 22

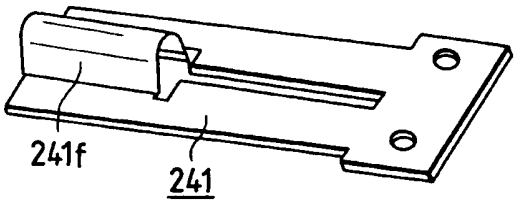


FIG. 19

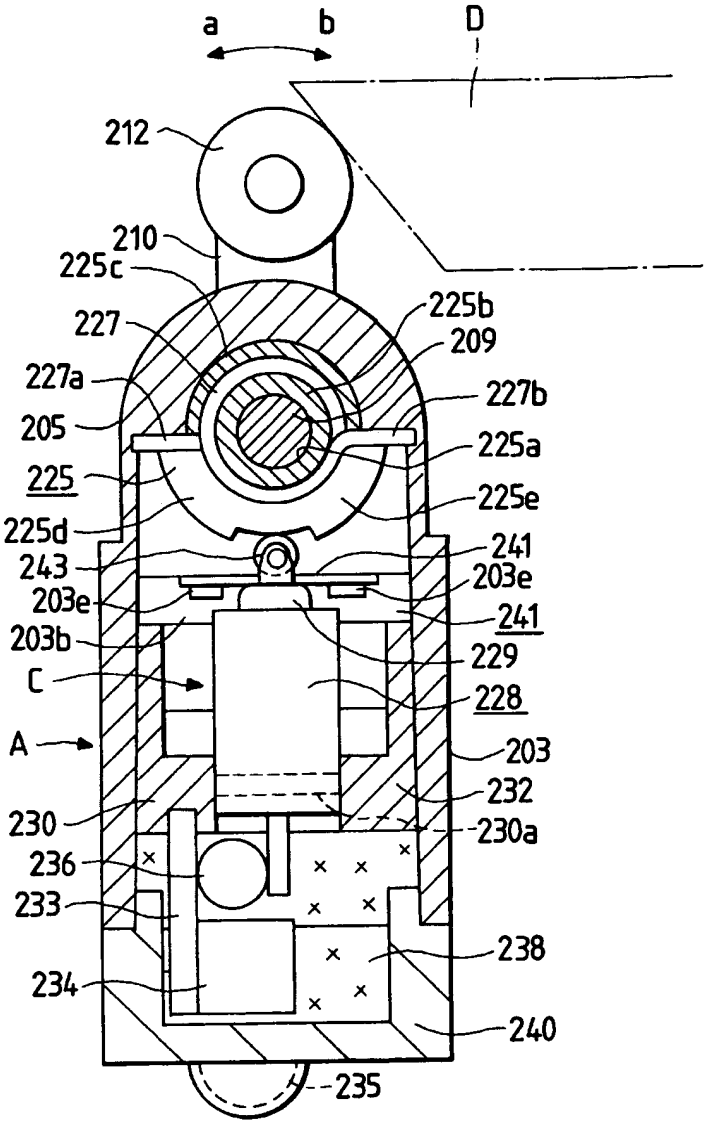

a
b
D
212
210
225c
227
227a
205
225
225d
243
203e
203b
C
A
230
236
233
234
225b
209
227b
225a
225e
241
203e
241
229
228
203
232
230a
238
240
235

FIG. 20

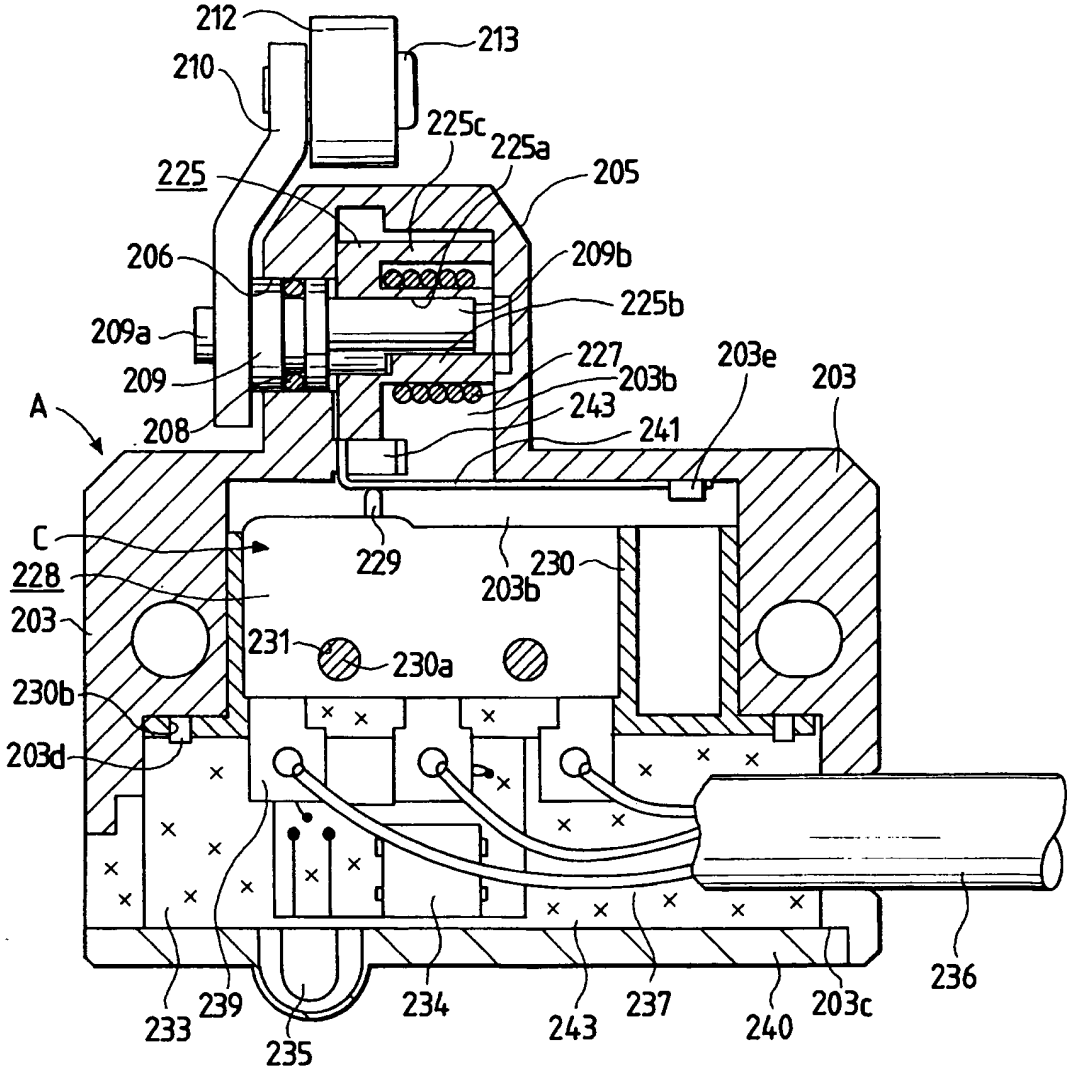

212
213
210
225c
225a
225
205
206
209b
225b
209a
227
203e
203
209
203b
A
243
208
241
C
229
230
228
203b
203
231
230a
230b
203d
236
233
239
234
243
237
240
203c
235

FIG. 23

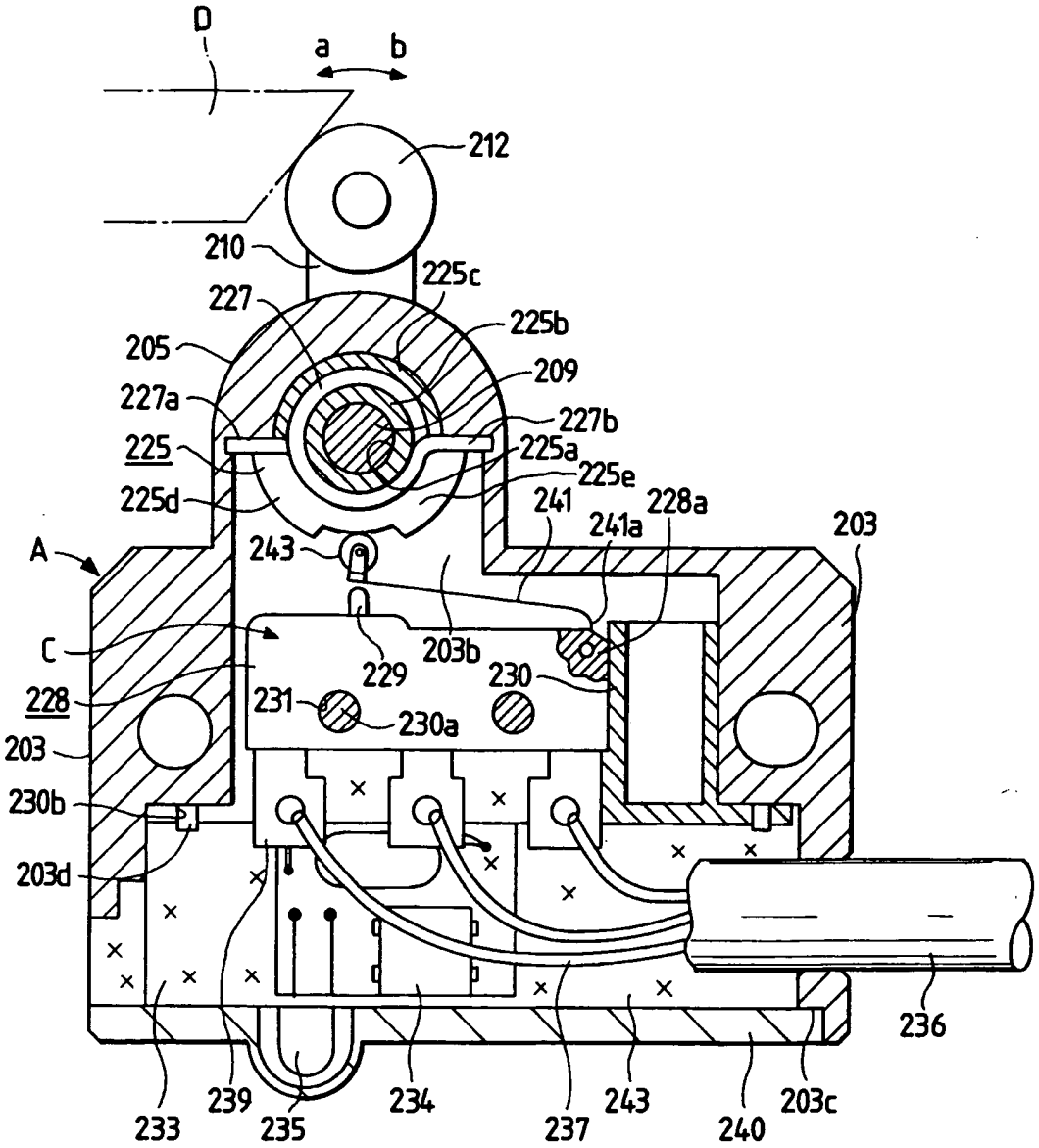
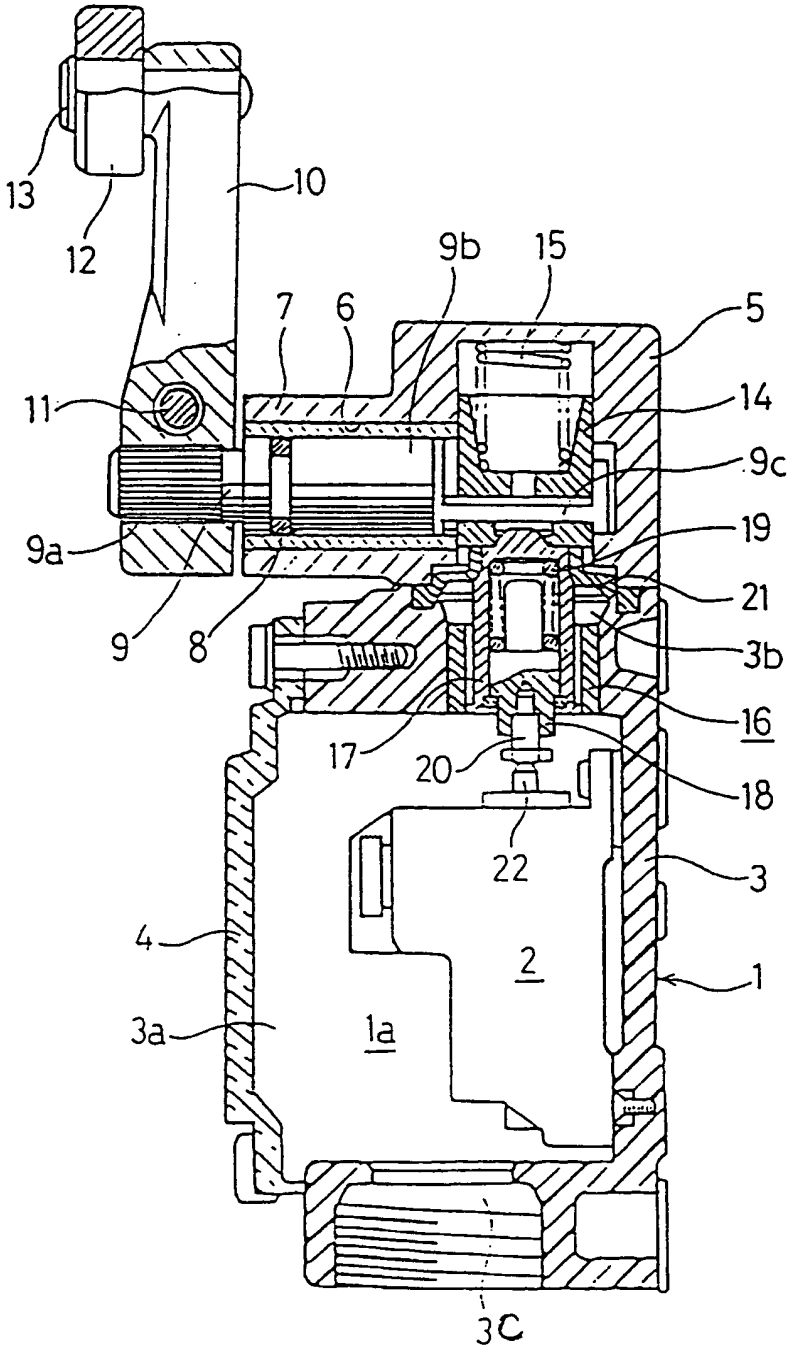

D
a
b
212
210
225c
227
225b
205
209
227a
227b
225
225a
225e
225d
241
241a
228a
203
A
243
C
229
203b
230
228
231
230a
203
230b
203d
236
233
239
235
234
237
243
240
203c

FIG. 24



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 30 8164

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-1 939 205 (ROBERT BOSCH GMBH) * page 3, paragraph 1 - page 4, paragraph 3; figures 1,3 *	1,2,7	H01H21/28 H03K17/965 H01H21/28
X A	FR-A-1 492 199 (ELECTRICITE DE FRANCE) * page 4, left column, paragraph 1-2; claim 1; figures 2,4,6,8 *	1,2,7 5	
A	US-A-3 364 318 (L. J. BULLIET) * column 1, line 14 - line 41 * * column 2, line 10 - line 68 * * column 5, line 16 - column 7, line 27; figures 1,4,5 *	1,6,7	
A	SOVIET INVENTIONS ILLUSTRATED Section EI, Week D17, 3 June 1981 Derwent Publications Ltd., London, GB; Class V03, AN D7721D/17 & SU-A-750 601 (GPTIKUZMASH PRESS) * abstract *	1,4,7	
A	EP-A-0 221 513 (OMRON TATEISI ELECTRONICS CO.) * page 4, paragraph 2 - page 5, paragraph 1; figure 1 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.5) H01H H03K
A	US-A-3 524 111 (K. MAECKER ET AL.) * column 1, line 39 - line 72 * * column 5, line 66 - column 7, line 26; figures 1-4A *	1	
A	CH-A-470 747 (A. BRUNNER) * the whole document *	3,4,6	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	16 DECEMBER 1992	RUPPERT W.

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L : document cited for other reasons

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